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Developing a Crowdsourcing Application for Responsible Production in Africa

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ABSTRACT

With modern supply chains spanning the globe, materials or components that companies use in their products may be sourced from areas prone to injustice and human rights abuse. A major challenge stakeholders face is the gathering of accurate data regarding producers in these areas. In this paper we introduce CARPA, a web application designed to gather reports on incidents and initiatives related to responsible production through crowd-sourcing. We describe its user-centric iterative process of development as well as its design and how this is influenced by the application context. Finally we discuss the challenges faced and the way forward.

CCS CONCEPTS

• **Information systems** → **Crowdsourcing**; • **Human-centered computing** → *Accessibility design and evaluation methods.*

KEYWORDS

crowd-sourcing, user-centered design, progressive web application

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1 INTRODUCTION

Modern supply chains span the globe with companies and individuals from different countries each providing materials or producing some component part. This can sometimes include producers and suppliers who operate in countries or areas with weak institutions or low governance. Producers in such areas may be prone to suffer greater injustice therefore addressing these problems was seen as an important enough concern that responsible value chains, which entails, among others, offering decent work conditions, fair wages and transparency throughout the Value Chain, was included as part of the United Nation's Sustainable Development Goals (SDGs) [3]. Besides the SDGs, companies have also been encouraged by public pressure and stakeholders to ensure that their products are made in a responsible manner, ensuring that they do not source materials from or produce in areas of conflict or injustice. At the same time, these companies and their supply chains are a dependable source of income in said areas where alternate means of income are hard to find at an individual level and at a national level [14].

The challenge associated with production in areas of low governance or areas described as 'post-conflict' is the potential for mistrust between stakeholders in the area [9] brought about by periods of conflict or abuse of civilians. This has led to difficulties gathering empirical data in such areas [7] as there is no single source of potential information seen as impartial or unbiased. For this reason, new methods of gathering data in low-governance areas are needed.

The rapid adoption of mobile and Web technology is one such method. It has allowed individuals to access information previously difficult to obtain, as well as engage in communication with people in their immediate environment and beyond [15]. Therefore in areas in which institutions may not be able to assist in problem solving and enforcement, individuals might rely on community or crowd-based remediation and problem solving instead, enabled through technology.

The CARPA project has set out to do just that. Through developing a Crowd-sourcing Application for the Responsible Production in Africa (CARPA), the project aims to engage local stakeholders

in areas of low governance in order to facilitate discussion and promote dialogue within communities and with stakeholders in order to help provide a resolution to incidents as well as keep track of a number of metrics related to the areas the application operates in. Although initially users will be from NGOs, local government organisations, and local community leaders, the CARPA application is intended to be opened up to all interested parties, including companies and investment funds, in future updates. This allows for cross-organisational collaboration in the resolution of incidents which occur in the shared community or environment.

The CARPA application is intended to be free to use and remove barriers to its adoption to encourage its use for local stakeholders in low-governance areas. It is designed to have minimal hardware requirements in order to run on the user side as a large number of mobile phones bought in less-economically developed areas tend to be cheaper and therefore computationally less powerful and suffer from storage and bandwidth restrictions. The application is also designed to be easy to navigate to allow adoption by those who may not be highly technologically literate. In the following sections we describe the iterative design process and identify challenges in developing crowd-sourcing applications in low-technologically literate and low-governance areas. These include challenges around user authentication, application usability, and the application platform.

2 THEORETICAL BACKGROUND

In this section we introduce the concepts that act as a foundation for our paper and its associated project.

2.1 ICT4D

Information & Communication Technology for Development (ICT4D), is the term given to research and projects involving the use of ICT with the goal of socioeconomic development, most commonly targeting those of lesser material wealth in less-economically developed countries. ICT4D encompasses a variety of fields of research [16] with varying areas of attention and differing measures of outcomes. ICT4D 2.0, as an upgrade to ICT4D, encourages the use of mobile communication and technology as there is a wider spread adoption of such technology in developing countries [8].

The CARPA project is designed with a particular focus on reaching end users on their platform of choice, initially through the use of mobile apps alongside a website and thereafter through its transformation into a progressive web applications to be compatible with any web-enabled device. The application is initially designed for use in sub-Saharan Africa, with a focus on Mali, Democratic Republic of the Congo and Rwanda. CARPA is not intended to be a solution to the challenges the users will face but rather as a platform for the users themselves to provide solutions. This form of problem solving is best described by the term crowd-sourcing.

2.2 Crowd-sourcing

Crowd-sourcing in general can be defined as an application or project which enlists a number of humans to come together to solve a problem. Projects which are said to be taking advantage of crowd-sourcing are those which achieve or explicitly address certain criteria[6]. Crowd-sourcing projects take into consideration user recruitment, the contribution of these users, the combination of these contributions in order to solve the problem, and the evaluation of users and their contributions [5].

CARPA differs from typical crowd-sourcing applications in that it is not the creators or owners of CARPA who outline the problem which needs to be solved but rather users themselves can report a problem or incident onto the CARPA platform. Furthermore, CARPA differs from other incident reporting tools in the crowd-sourcing space in that the application is designed not only to crowd-source the reporting of incidents but also their resolution through the discussions which are open to users as well (cf. [11]). Users can contribute to these discussions based on previous experience, professional knowledge, or a combination of the two.

With users being a central part of the success of the CARPA application, a user-centric design approach is most likely to succeed.

2.3 User-centred design

Recent literature has promoted a greater involvement of end users in the development process of ICT4D projects [2, 4]. Said involvement should be regular and form a prominent part in justifying the design decisions taken.

User-centred design (also referred to as human-centred design) can be referred to as: "*an approach that puts human needs, capabilities, and behavior first, then designs to accommodate those needs, capabilities, and ways of behaving*" [10]. The CARPA application had to be designed with users in mind, especially given that many users in our ICT4D application context might not be familiar with a variety of (crowd-sourcing) applications. The CARPA application undergoes cycles of development, some which occur over period of months while others can be considered rapid-prototyping, whereby changes are made in a short amount of time based on user feedback to address issues raised. This cyclical approach allows us to quickly make changes and updates to the application and test these changes on potential end-users in regularly scheduled workshops.

3 APPLICATION DESIGN AND DEVELOPMENT

In the following section, we describe some of the major design considerations of the CARPA application as well as describe the cycles of development it has undergone to reach its current version.In each cycle, a variety of design changes were made to increase functionality and usability.

3.1 Application design outline

The language of the CARPA application is important to its success as users feel more comfortable using a language they are familiar with. For this reason the CARPA application allows users to select between English and French user interfaces. These two languages were chosen as they are the more predominant international languages spoken in western and central Africa. There is also consideration for including translations into local languages as a future development.

As the CARPA application is intended to be open to the general public, the content they provide needs to be verified and, if necessary, moderated. Upon registering an incident users are encouraged to provide supporting evidence in terms of images or

supporting documents. The addition of supporting media is encouraged throughout the discussion until a resolution is found. Should a user deem a post or discussion to be inaccurate throughout the discussion process users can report posts for review by CARPA moderators.

Due to the sensitive nature of the discussion which may take place within the application, user privacy is something which is taken into consideration. In order to accommodate this users who raise incidents or add contributions within the application can choose to use their real name, as shown in Figure 1, or can use a self-chosen pseudonym, Figure 2, to hide their identity should they feel their safety would be threatened.

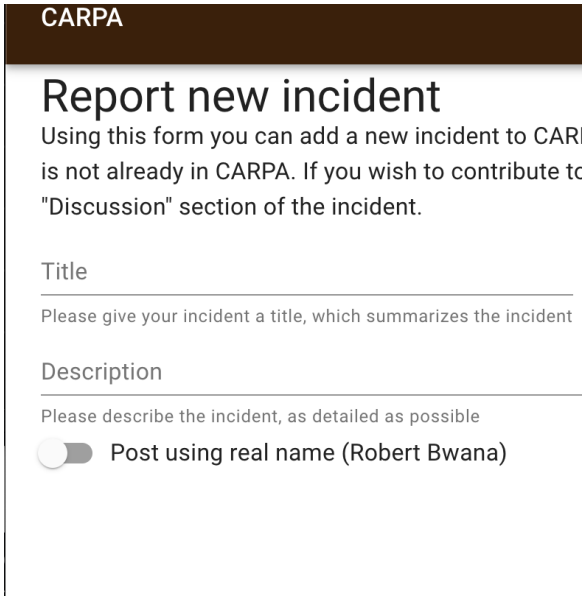

Figure 1: Screenshot of CARPA while using real name to raise incident.

3.2 Application design challenges

One recurring challenge is that of *user authentication*. CARPA as an application is intended to be open to stakeholders with different backgrounds and with different objectives including, but not limited to, incident reporting, incident resolution, monitoring of incidents, moderation of discussions, and reporting of new initiatives. These can range in size from private individuals and self-employed producers to multinational enterprises and national government agencies. It is necessary to identify and authenticate different users in a convenient manner which caters to respective capabilities and use cases while maintaining an appropriate level of security.

A second challenge is related to the *application platform*. In order to ensure the intended audience has access to the CARPA application it is necessary to ensure that it is accessible via multiple platforms and on a variety of devices. An early assessment showed that the majority of the prospective users are in possession of smartphones and therefore we look at deploying the application to this platform (cf. [12]).

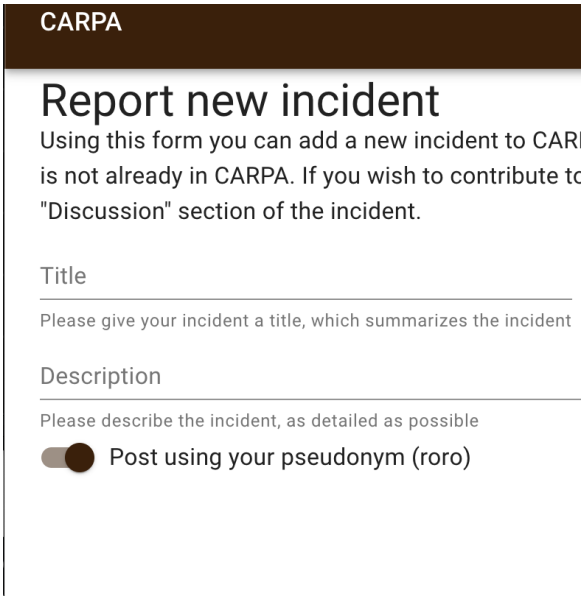

Figure 2: Screenshot of CARPA while using pseudonym to raise incident.

3.3 Cycle 1

This cycle commenced with the project kickoff workshop held in May 2018. The design decisions made in this cycle were based on standard development practices and the experience of the CARPA project team. This cycle concluded with the workshop held in Mali in March 2019 whereby the application was presented to a group of prospective users for testing and to gather feedback.

3.3.1 Users and user authentication. In this first iteration of the CARPA application, users were authenticated using self-selected usernames and passwords. These would be chosen by the user upon registration and would be needed to log in to the CARPA application. This method was chosen as it is a tried and trusted method of authenticating users and could be implemented without complication.

3.3.2 Application Platform. The app was initially designed as two modules: a mobile application and a website. The mobile application was written to be released on the Google Play Store for Android-based devices and on the Apple iStore for iOS-based devices. Figure 3 shows a screenshot of the homepage once a user has logged in featuring a list of incidents which have been raised. The website was intended to provide an administrative view of the application as well as quantitative elements of the application.

3.4 Cycle 2

The second cycle began once the feedback from workshop 2 was gathered in Mali. This saw the most sizeable changes in the CARPA application based on the comments and suggestions received from the workshop participants as well as from observations by the CARPA project team in attendance of how the application was being used by the participants. The changes made to the application

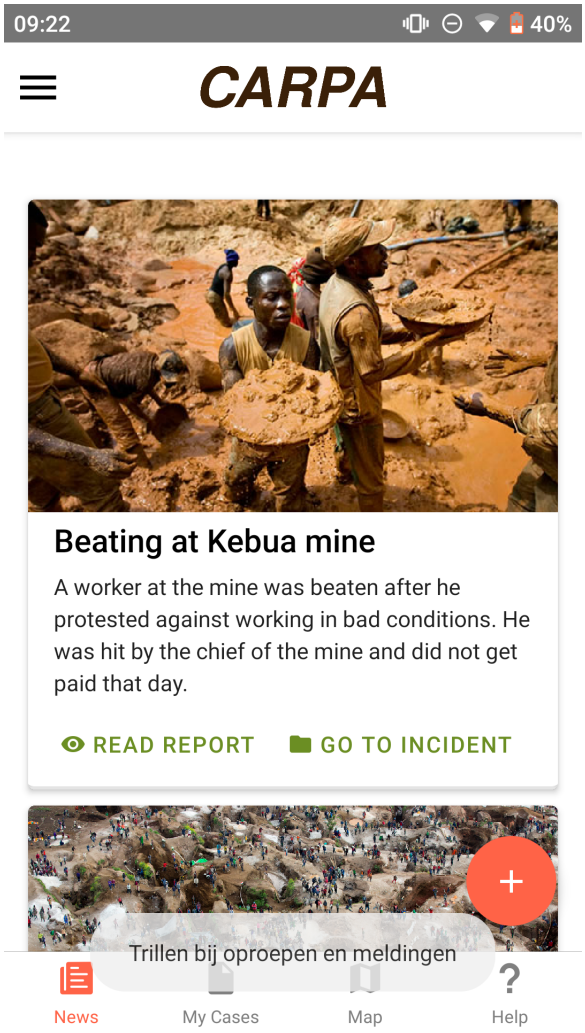

Figure 3: Screenshot of CARPA app sample homepage showing incidents as items on a scroll-able list.

were presented and tested in another workshop of potential users held in Kigali, Rwanda in September 2019.

3.4.1 User authentication. During the workshop, we observed that the username and password combination was not ideal for a number of participants. Either since too simple passwords were used or participants forgot login credentials frequently. It was also noted that participants had difficulty with the process and concept of requesting password resets through email. For these reasons an alternate user authentication method was considered.

This new user authentication method was that of a token-based authentication. Users would enter their mobile phone number and an SMS containing a 6 digit token would be sent by the CARPA application to their number, provided the mobile phone number was a valid one and of an already registered user in the system. The user would then be required to enter the token sent via the 2nd channel into the CARPA application to authenticate themselves. This was designed as a simpler alternative which would no longer require the user to remember login credentials.This approach was implemented into the system to be tested in the following workshop.

3.4.2 Application platform. Based on feedback of the first workshop, CARPA was re-engineered as Progressive Web Application (PWA) [13], with a standard interface across all platforms. This meant a common interface and a common platform for all users. The use of a progressive web application would mean a reduced data storage footprint on the users' mobile devices which was observed as a challenge during workshop 2. As progressive web applications are downloaded similar to traditional web pages this would solve the storage-space problems encountered. Figure 4 shows an image of the CARPA application after being re-engineered as a progressive web application.

Additionally, as progressive web applications are treated similar to traditional web pages the use of PWAs would allow the CARPA application to be updated on the server side with requiring the users to download the updates to the application, a concern which they raised during the workshop.

3.5 Cycle 3:

The third cycle began with the feedback obtained from workshop 3 held in Kigali in September 2019.

3.5.1 Users and User authentication. With the token based system, users who were able to receive the token via SMS reported a simpler login experience. The only problem encountered was that users who had travelled from a different country encountered problems with receiving the SMS when sent to their local mobile phone number. This may result in users not being able to access the CARPA application if they are outside of their usual country and not able to receive SMS where they are. It was therefore necessary to introduce an alternate channel which could be received universally. It was decided to allow for users to select to receive the token via email rather than SMS. Figure 5 shows the CARPA application login page where users can select which channel they wish to use to receive the login token.

3.5.2 Usability evaluation. In addition to focus group discussions, we also conducted a quantitative study into the usability of the application. For this, we used the System Usability Scale (SUS) [1]. In total, 21 participants (14 in the first and 7 in the second workshop) judged usability of the application using the 10 SUS questions. This resulted in a SUS score of 81.7, which indicates a high perceived usability. While the setup of the evaluation (only one system tested, in a workshop setting) does not provide us with conclusive evidence of the usability, the outcome matches the overall very positive response in the focus group discussions.

3.6 Cycle 4

The fourth cycle began with the conclusion of workshop 4 held in Gisenyi and Cyangugu, Rwanda in March 2020 and is at the time of writing still in progress. In the two workshops the system was demonstrated and prospective end users were allowed to interact with the system. Next, they were asked to register for the platform and test out several of the function of the application. They then were asked to perform a series of user tasks using the

Figure 4: Screenshot of CARPA progressive web application sample homepage.

system, including. 1) Browse the application; 2) Report an incident; 3) Contribute to other incident; 4) Reply to a report from another participant and 5) add an image to an incident report. Participants were then asked to reflect on the platform and the usability of the application.

3.6.1 User authentication. Now, when unable to receive an SMS, users were able to log in using the alternate email channel when shown how to do so. For users who were comfortable with accessing emails this was not a problem, however there were a few users who found it cumbersome to have to log in to their email accounts on their smartphones while also switching to the CARPA web application in order to enter the token. It was agreed that we would look into further authentication options which would be suitable based on the complaints that they raised.

3.6.2 Usability. Having experienced the application, users requested the addition of filters in the main newsfeed. While users can currently select the incidents and initiatives they themselves have raised, they requested the addition of a filter of the general posts so that they can find posts which they feel would be more relevant to them or to which they can better contribute.

4 DISCUSSION AND CONCLUSION

In this section we discuss the lessons learnt during the development process so far as well as the next steps for the CARPA application and project.

4.1 Design decisions

Through the cyclical approach to the development of the CARPA application, we have been able to benefit from the first-hand experience of users and involve them in the development process. This has resulted in changes in the application, both major as well as minor. The regular interaction with users has allowed us to understand their expected interactions with the CARPA application as well as their suggestions for further improvements.

The most notable change brought about was in the application platform. Whereby initially the CARPA application was written as a mobile application, the problems encountered with bandwidth and storage space resulted in the change to a progressive web app. This new platform requires less storage space and updates can occur on the server-side instead. In order for ICT4D projects to succeed, they must take into consideration or take advantage of the infrastructure in place in their environments [8]. The use of progressive web applications in these environments could remove barriers in the adoption of the projects. A more structured comparison of mobile

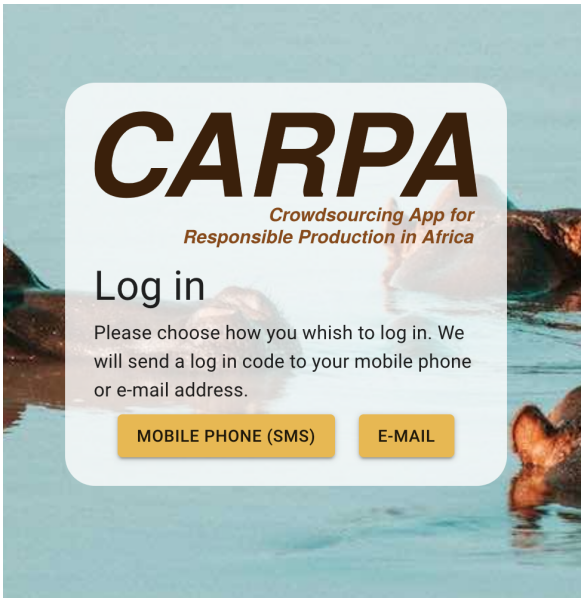

Figure 5: Screenshot of CARPA login page showing the multi-channel login option.

applications versus progressive web applications is an interesting area for future research.

User authentication remains a challenge. While username and passwords may have seemed straightforward when initially designing the system, through interactions with users this assumption was proven false. Despite the further attempts to find an ideal authentication method, this still remains an important aspect of the CARPA application which needs to be completed. It may therefore be necessary when designing applications for less technologically-fluent users to consider alternative authentication schemes.

4.2 Future work

The CARPA application will be continuously improved in next development cycles. Firstly, a suitable authentication system needs to be implemented which is secure and easy to use. This remains the biggest challenge in terms of the fundamental design of the CARPA application. Various authentication schemes are to be considered which will then be implemented and tested with the users once again.

Due to the intermittent Internet failures in some of the environments in which the CARPA application is expected to be used, various other methods of interaction with the CARPA application are being investigated. One such method is the use of Interactive Voice Response functionality to allow phone calls to act as an input method into the application. Another method which has attracted interest is the use of text messaging and chat applications to interact with the CARPA application. Besides the inherent challenges in these technologies, we will have to consider how the ethos of crowd-sourcing and discussion-based problem solving can be managed when using such methods of interaction. Users reported that despite the low numbers of cases being reported at the moment, it can still take some time or an inconvenient amount of scrolling until an incident related to their area of expertise or their geographical area appears. Filters are therefore planned to be introduced to allow users to filter the incidents and initiatives to their preference. An automated filtering can also be considered based on prior user contributions in order to maximise the benefit a certain user can have in the problem solving process.

To further expand the accessibility of the CARPA application, sub-modules are being considered to compliment the application with a non-text-based input and output interaction system. These include, but are not limited to, the use of images and icons to complement written instructions and descriptions as well as the use of a voice-based system to allow interaction by users who may not be as textually literate.

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